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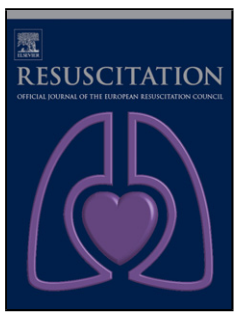

Title: Extracorporeal life support in hypothermic cardiac arrest: reconsidering trauma as an absolute contraindication

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Extracorporeal life support in hypothermic cardiac arrest: reconsidering trauma as an absolute contraindication.

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Sir,

we report a case of hypothermic cardiac arrest in a patient with strong clinical suspicion of severe traumatic brain injury to initiate a wider discussion on when eCPR should be attempted in hypothermic trauma patients.

A seven year-old boy stumbled on a hiking path, slipped underneath the rope railing, fell 40 meters into a canyon and was submersed in a cold mountain creek. It took at least 20 minutes before the boy was extracted. The rescue crew found him with an unobstructed airway, bradypneic and bradycardic with brachial pulses, GCS was 5. A bodycheck showed no injuries, his temperature was 24.4°C. Soon, the patient developed a generalized tonic seizure and received 3mg midazolam i.o. at an estimated body weight of 30kg, was immobilized, intubated, and externally warmed. During landing at our trauma center, circulation deteriorated to PEA and CPR was initiated. We performed bilateral needle chest decompressions to rule out tension pneumothorax. Primary survey revealed a negative FAST, bilateral pulmonary edema compatible with fresh-water aspiration, an otherwise negative whole-body X-ray, and a right pupil larger than the left. We inserted bilateral chest drains, recorded a core temperature of 27.5°C, an arterial pH of 7.3, potassium of 2.4 mmol/l and lactate of 4 mmol/l.

A multi-disciplinary decision was made to institute eCPR with central cannulation. A minimized extracorporeal circulation (MiECC) system with a heparin-coated circuit was started without systemic heparin. At the start of cardiac surgery, the difference in pupil size increased. We suspected a growing intra-cranial hemorrhage and performed an exploratory

burr hole [4] over the right frontal convexity concurrently. Intracranial opening pressure was 40cm H_2O. Forty milliliters of blood were removed from the epidural space. Intracranial pressure normalized thereafter, and pupils became equal again. The patient converted to sinus rhythm following one internal DC countershock (10 J) at a temperature of 29.2 °C. Pulmonary edema was evident with frothing from the endotracheal tube despite high PEEP. This prompted us to exchange the MiECC with a veno-arterial centrifugal pump ECMO to allow for protracted weaning at a core temperature of 34.0 °C. A postoperative CT revealed multiple intracranial concussion bleedings and remnants of a right frontal epidural hematoma, but no other traumatic injuries. Mild hypothermia was maintained for 14 hours and the patient weaned from ECMO after a total of 48 hours. Systemic heparin was withheld for the first 24 hours; afterwards, we aimed for an activated clotting time of 170 seconds. At discharge on day 36, the boy retained a weakness in his right arm and a right-sided facial nerve paresis. Otherwise independently functional (CPC 2), he now interacts and plays normally.

Despite encouraging case reports (table), the role of ECLS and eCPR in hypothermic arrest patients with trauma is yet to be clarified. Our report and the comparably good neurological outcomes in hypothermic arrest patients overall [5] suggest to reconsider trauma, and TBI in particular, as a general contraindication to ECLS. Existing algorithms should be further refined to account for trauma extent, location and consequences.

Conflict of interest statement

WEH has received research funding from Mundipharma Medical Basel, CH, research support in kind from Prytime Medical Boerne, USA, support for a conference he chaired from Mundipharma Medical Basel, CH, Isabell Healthcare, UK, EBSCO, GER, and VisualDx, USA and speakers honorarium from AO Foundation Zurich, CH. BE has received speaker´s

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The authors obtained patient and guardian consent to the publication of this report.

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Table: Reports of trauma cases[1)] with immediate use of extracorporeal life support (ECLS) or eCPR

Publication	**Patient, Trauma mechanism**	**State on ED arrival**	**Injuries** (and interventions where reported)	**Type of ECLS**[2)]	**Neurological Outcome**
Darocha et al. (2015)[1]	Adult male, age unknown, found in street	Heart rate: 20/min Temp: 25°C Immediate CPR.	multiple rib fractures, Th6 vertebrae fracture, perihepatic and perisplenic fluid. Small pericerebral hematoma over right temporal and parietal lobe, fractures of right occipital and parietal bones, all attributed to previous craniotomy	Femoral v-a ECMO	CPC 1
Winkler et al. (2016)[2]	59 yo male, 15m mountain fall	CPR. Temp: 25.3°C	bilateral serial rib fractures, dislocated right hip fracture and an open-book pelvic ring fracture (immediate external fixation) with active retroperitoneal bleeding (immediate embolization)	Femoral v-a MiECC	CPC 1, return to work as professional mountain guide
Ting & Brown (2018)[3]	53 yo male, ejected from car	Heart rate: 60/min, blood pressure: 60/39 mmHg Temp: 23.5 °C	C4–C5 ligamentous injury (eventual stabilization), severe frostbite to right hand (partial amputation of all digits eventually)	Femoral v-a ECLS	full neurologic recovery
This report	*7yo boy, 40m fall into creek, submersed*	*CPR. Temp: 27.5°C*	*multiple small intracranial concussion bleedings, small remnants of a right frontal epidural hematoma (after drainage through exploratory burr hole)*	*Central MiECC*	*CPC 2*

[1)] As reported in the original publication. [2)] ECMO: extracorporeal membrane oxygenation. MiECC: minimized extracorporeal circulation. ECLS: extracorporeal life support. eCPR: extracorporeal cardiopulmonary resuscitation